

# **CLEAN COAL IN A COMPETITIVE ELECTRICITY MARKET**

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## Coal in Sustainable Development in the 21<sup>st</sup> Century

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### ABSTRACT

*New technologies for electricity supply that are under development to meet future demands are being driven by two main factors:*

- *The de-regulation of the electricity industry from centralised State-owned monopolies to a competitive market.*
- *Environmental issues in relation to atmospheric (and other) emissions from the production of electricity.*

*On the one hand the technology must have low emissions (particulates, SO<sub>2</sub>, NO<sub>x</sub> and greenhouse gases) and on the other they must provide competitive electricity in the free market. These two objectives are mutually exclusive and only pressure by Governments is forcing utilities to increase the price of electricity to pay for lower emissions.*

*Many see coal as the main contributor to the global environmental problems. However, it is only now that these people are realising that it is not feasible to replace coal as the major energy source of the world. So what do we do? The energy industry has the answer, and it lies in new technologies based on zero emissions.*

*This paper overviews the trends in the deregulated electricity market and discusses the issues relating to the implementation of new electricity generation technologies in this market. It also discussed the response from the coal industry that might be appropriate to turn black (or brown) coal slightly green.*

# Clean Coal in a Competitive Electricity Market

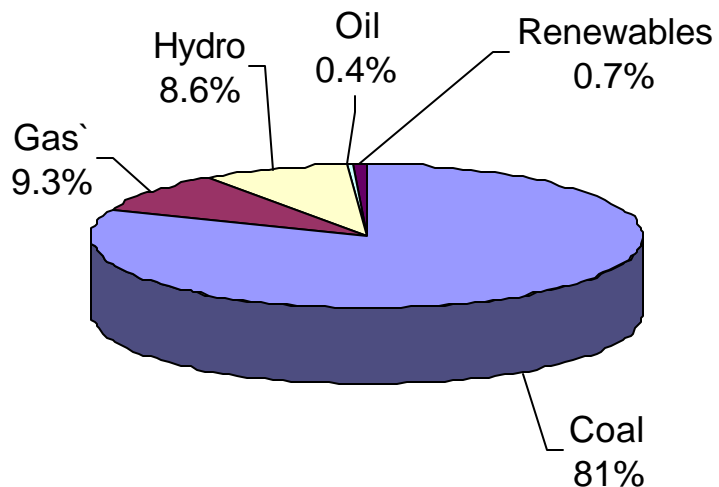
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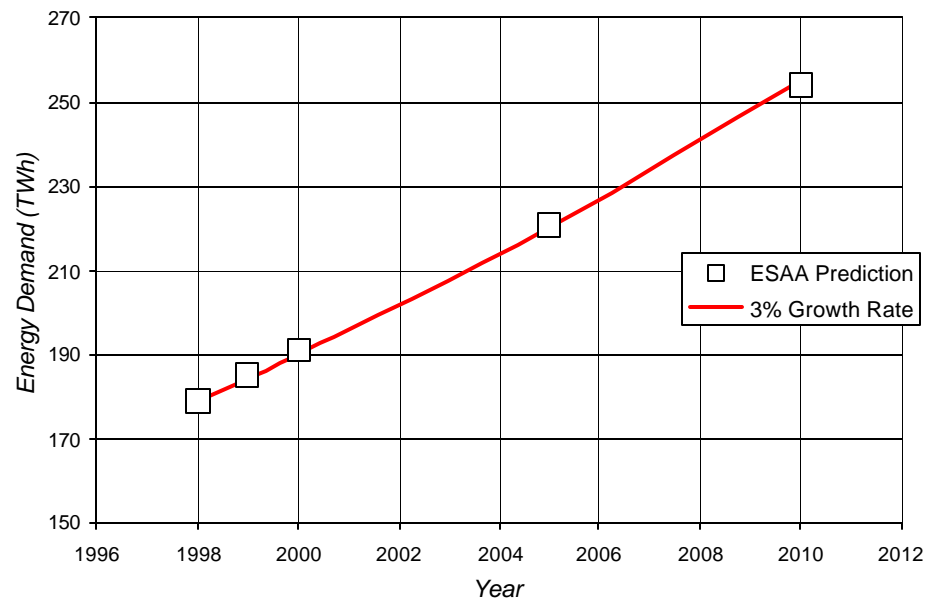
## Overview

- ◆ Electricity Supply in Australia
  - Trends, Renewables
- ◆ Incentives for Development of New Technologies
  - Costs, Environmental
- ◆ Power Plant Technologies
- ◆ Environmental Performance
  - Efficiency, Pollutants, Greenhouse, Costs
- ◆ Green Coal & Greenhouse Gas
  - Who are the Emitters?
  - Implications for the Coal Industry

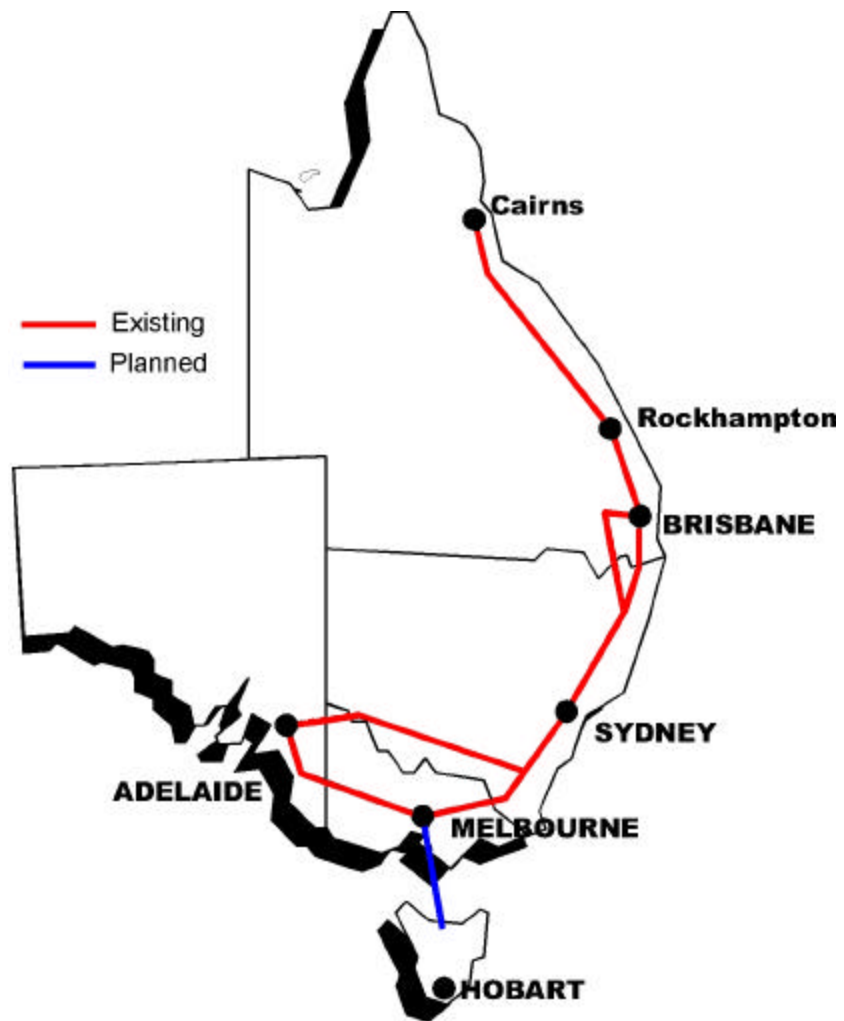
# Electricity Supply in Australia



- 44 GW Installed Capacity
- Up to 58 GW in 2010

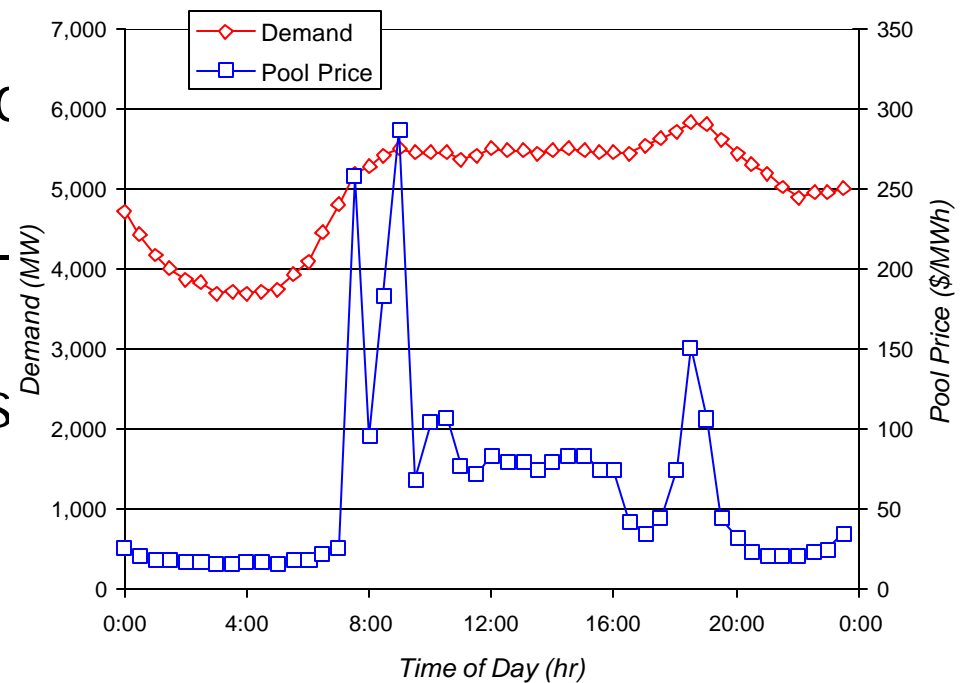


# Interconnected System



## NEM - The “spot” market

- ◆ Central Pool controls dispatch
- ◆ Generators bid in half-hourly intervals
- ◆ Wholesale market bid for energy
- ◆ Generators paid half-hourly spot price
- ◆ Wholesale customers pay spot price less losses



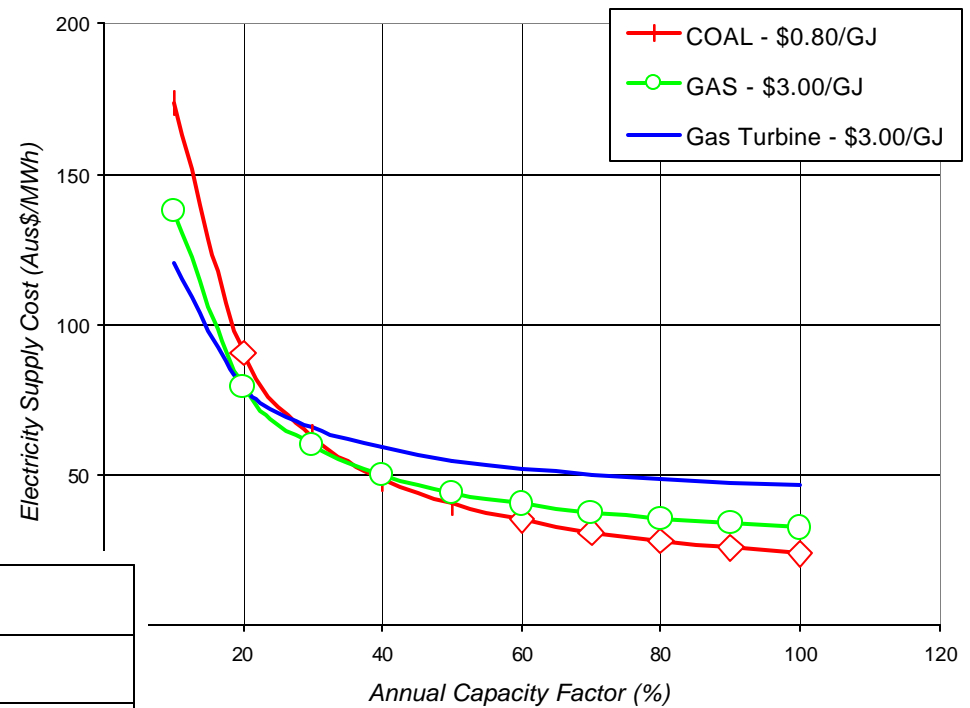
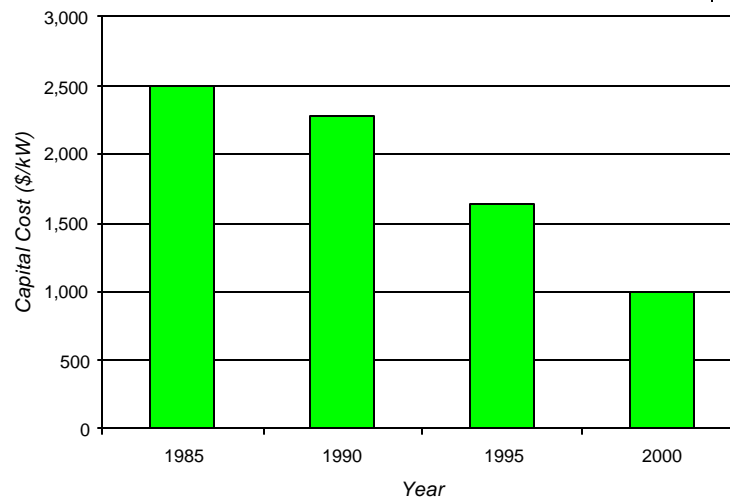
## Renewables

- ◆ Solar
- ◆ Wind
- ◆ Tidal & wave
- ◆ Hydro
- ◆ Geothermal
- ◆ Biofuels
- ◆ Wastes
- ◆ Co-firing

Source	Capacity (MW)	Energy (GWh)
Hydro	7,500	20,000
Bagasse	340	1,200
Wind	32	70
Solar	1	4
Total	7,873	21,274

# Incentives - Costs

- ◆ Capital
- ◆ O&M
- ◆ Fuel
  - Change fuels
  - Cheaper coal



## Incentives - Environmental

### ◆ Greenhouse gases

- Type of fuel
- Cycle efficiency
- Renewables

### ◆ Others

- NO<sub>x</sub>
- SO<sub>2</sub>
- Particulates

Fuel	CO <sub>2</sub> Emissions (kg/MWh)
Coal	850 – 900 for sub-critical, down to 800 for super-critical
Natural gas	500 – 600
Renewables: Solar	Zero (Not allowing for Whole of life emissions)
Renewables: Biomass	>1,000 but considered CO <sub>2</sub> neutral

# Power Plant Technologies

- ◆ Coal
  - Super-critical PF
  - IGCC
- ◆ Gas
  - Advanced GT
  - Fuel cells
- ◆ Renewables
  - Solar: voltaic, thermal
  - Wind
  - Biomass
- ◆ Zero CO<sub>2</sub>

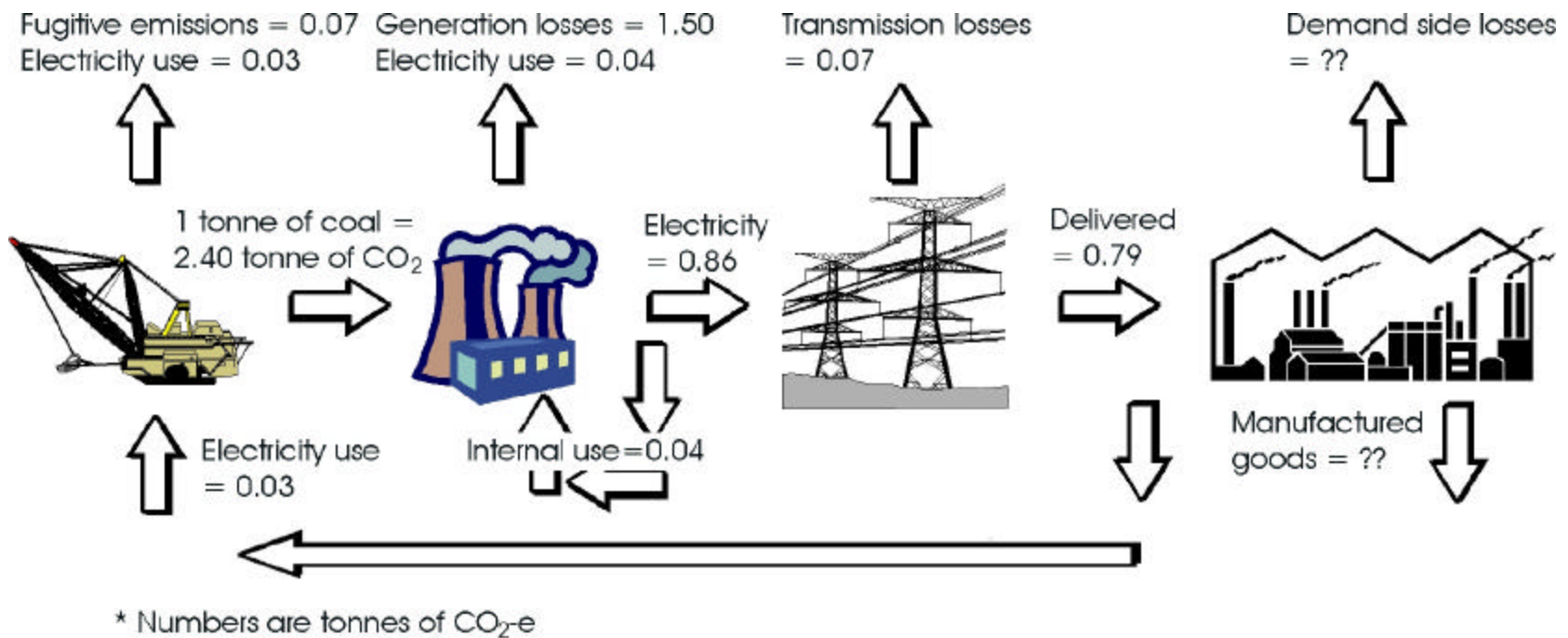
# Environmental Performance

	Coal	Gas	Renewables			
			Solar PV	Solar Thermal	Wind	Biomass
<b>Plant Details</b>						
Unit Size	200 – 1,300 MW	200 – 750 MW	0.01 – 1 MW	Up to 200 MW	Up to 2.5 MW	Up to 100 MW
Capacity factor	75 – 95%	75 – 95%	5 – 20%	5 – 20%	Highly site specific, but typically around 20 – 50%	50 – 80 depending on availability of fuel
<b>Emissions</b>						
Particulates	Low but needs gas clean-up	Not significant	Zero	Zero	Zero	Low but needs gas clean-up
SO <sub>2</sub>	Depends on coal sulphur content	Not significant	Zero	Zero	Zero	Depends on fuel sulphur content
NO <sub>x</sub>	High uncontrolled. Moderate with appropriate clean-up	Expensive	Zero	Zero	Zero	Very cheap
CO <sub>2</sub> (kg/MWh)	800 – 900	460 – 600	Zero – but has significant “whole of life “ emissions	Zero+	Zero+	Very high – taken as CO <sub>2</sub> neutral
Cost of Compliance	High	Moderate	Low	Low	Low	High

# Cost of Compliance

Cost Item	Coal-Fired Plant	Gas-Fired CC
Air pollution control	6 – 18 %	0 – 6 %
Cooling	0 – 2 %	0 – 3 %
Waste disposal	??	
Environmental charges	0 – 9 %	0 – 5 %
<b>Total</b>	<b>10 – 26 %</b>	<b>0 – 9 %</b>

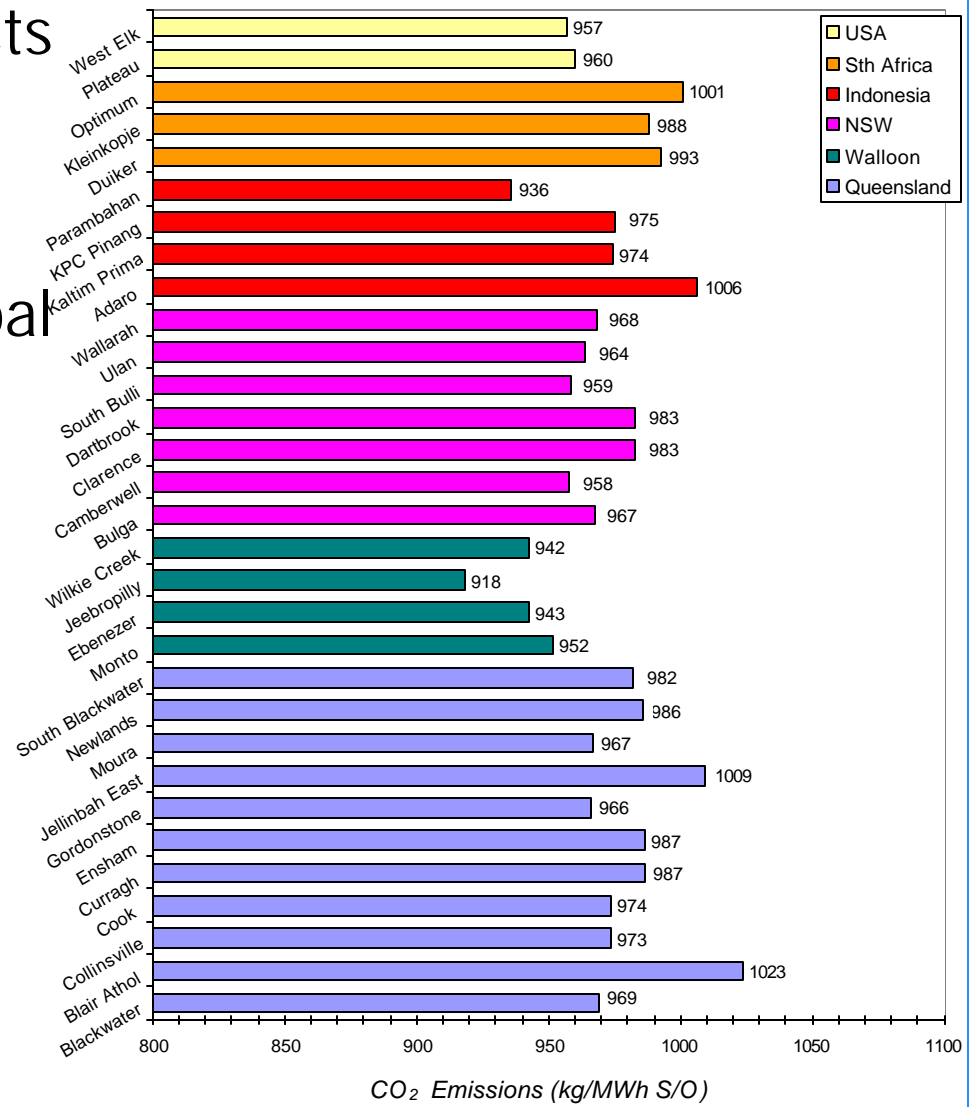
# Green Coal



Who are the emitters?

# Implications for the Coal Industry

- ◆ Bundled coal contracts
- ◆ Clean coal
  - Coal quality
  - Blending
- ◆ Low GHG (clean?) coal



## There is a Solution

- ◆ The world cannot do without coal in the medium term
- ◆ This means that some rational debate may eventuate
- ◆ Clean coal technology has come a long way
  - But not far enough
  - Zero emissions is the answer

*We recognise that the use of coal is not clean enough for our children, but we have the answer, and we're working on it!*